BEST COPY
AVAILABLE

Third United Nations International Conference on the Peaceful Uses of Atomic Energy

A/CONF.28/A/724
NETHERLANDS
February 1964
Original: ENGLISH

Confidential until official release during Conference

Abstract

UTILIZATION OF THE HIGH FLUX REACTOR AT PETTEN

J.J.M. Snepvangers et al., Reactor Centrum Nederland, Petten, Netherlands, M. Grenon et al., Euratom Petten, Netherlands, H. Postma et al., Stichting F.O.M. Utrecht, Netherlands and K.F. Maartmann-Moe, Institutt for Atomenergi, Kjeller, Noorwegen

The 20 MW High Flux Reactor (H.F.R.) is owned by the European Atomic Energy Community (Euratom), as part of its research establishment at Petten. The reactor is operated by the Netherlands nuclear energy organization, Reactor Centrum Nederland (R.C.N.), and used jointly by Euratom and R.C.N. Both parties co-operate with other organizations in the execution of experiments. As regards Euratom, these are mainly organizations in the other five countries of Euratom.

R.C.N. carries out a number of experiments of its own, and also some in co-operation with the Norwegian Institutt for Atomenergi (I.F.A.). Other experiments are done by R.C.N. under contract. Some of the beamholes have been made available for nuclear physics experiments to University teams working under the auspices of the Netherlands' Organization for the Fundamental Investigation of Matter (F.O.M.).

The organizational aspects of the use of the reactor by several parties will be discussed, after which the more important experiments will be described.

Five of the horizontal beamtubes are at present used for neutron physics research. All of them are equipped with standard collimators. Two of the beams are used for neutron diffraction research (I.F.A./R.C.N.), one utilizing polarized neutrons and the other one being equipped with a powder and a single crystal spectrometer. Two beamtubes are used for capture gamma ray experiments (F.O.M.), and in one beam research on the inelastic scattering of thermal neutrons (I.F.A./R.C.N.) is carried out. The majority of the experiments in or near the fuel region of the core is of

the so-called instrumented capsule-type, others are carried out in loops. The majority of these irradiation experiments aims at the investigation of non-fissile materials, a smaller number is for reactor fuel research.

R.C.N. carries out two uranium oxide fuel irradiation experiments in loops: one is a low pressure facility (used together with I.F.A.), while the other one is a pressurized water loop for the investigation of prototype fuel elements for the NERO ship propulsion project. Euratom carries out a number of fuel investigations in instrumented capsules: uranium oxide fuel pencils are irradiated in the poolside facility of the reactor, while another rig is used for uranium carbide research.

Graphite irradiations are performed for several organizations. R.C.N. has developed equipment for the O.E.C.D. Dragon project in which graphite samples are irradiated at 600, 900 and 1200°C. Euratom performs graphite irradiations both for its own programme and for third parties. Pressure vessel steels are investigated under an I.F.A./R.C.N. joint project; at low temperatures in non-instrumented equipment and at elevated temperatures in a loop using an organic coolant. Stainless steels are being irradiated by Euratom. Other reactor positions are used for the investigation of a large variety of materials such as beryllium, beryllia, thermo-couples, zircaloy, strain gauges, and zirconium hydride. The reactor is also used for the production of radioisotopes for commercial uses or for research. Standard irradiation facilities are available for that purpose.

Third United Nations International Conference on the Peaceful Uses of Atomic Energy

A/CONF.28/A/725
NETHERLANDS
February 1964
Original: ENGLISH

Confidential until official release during Conference

Abstract

The "Biological Agricultural Reactor Netherlands" -BARN-

M. Bogaardt, J. Coehoorn, W. Hofman and W.W. Nijs
Reactor Centrum Nederland, The Hague and Petten

The "Biological Agricultural Reactor Netherlands" of the Institute for the Application of Atomic Science in Agriculture at Wageningen has been designed by Reactor Centrum Nederland and has been specially equipped for fundamental and applied research in the agricultural and biological field. The reactor, a modified swimming pool type with a power of 100 kW, is used as a source for thermal and fast neutrons to perform irradiations of both chronic and acute nature.

The reactor is equipped with the following irradiation facilities:

1) Climatological controlled irradiation room of 5 x 7 meters and 3 meters high for thermal and fast neutron irradiations.
2) Thermal column with a thermal neutron irradiation facility of 70 x 70 x 30 cm.
3) Two 150 mm diameter beamtubes.
4) Reflector positions in the lateral graphite reflector of the reactor core. Provisions have been made for future installation of max. 3 pneumatic rabbit systems with their irradiation stations in the lateral reflector of the reactor core.

The main special feature of this reactor is the neutron irradiation room situated directly below the reactor core. As this implied that the reactor fuel had to be as close to the pool bottom as practically possible, in order to reduce neutron losses in the pool water to a minimum, a very special core support system was designed. In this core support system there is no conventional grid plate, and the MTR type fuel elements are suspended in an egg crate type lattice.

The neutrons from the core streaming in downward direction, pass through a heavy water filled diffusor of special shape with overall dimensions of 120 cm length and 125 cm diameter, and through a system of gamma filters made

of pure bismuth with a total thickness of 17.5 cm. The neutrons entering the irradiation room have a low gamma contamination (about 10%) and a low fast flux contamination (cadmium ratio for gold >350). The irradiation field provided, is at least 2 m^2 in surface, with an average thermal neutron flux of 5.10^6 neutrons/sec.cm^2 when the reactor is operated at 100 kW. The maximum local variation in flux is $\pm$ 5% relative to the average value.

Fast neutron irradiations can be performed either by transforming the thermal flux in fast flux by means of a fission plate or by reducing the heavy water layer between core and irradiation room and use of thermal and epithermal neutron filters.

The irradiation room itself can be completely controlled regarding temperature, humidity and light intensity. All free surfaces of the room are lined with special materials to limit radiation scattering, activation and production of capture gamma's.

To permit independent operation of the thermal column facility when the reactor is in operation, the shielding door of the thermal column has been so designed that experiments up to 70 x 70 x 30 cm in size can be transferred in and out the facility with the reactor operating at full power.

During the commissioning of the reactor and its facilities from April - September 1963, various experiments were carried out and extensive neutron flux and gamma flux measurements were performed. Especially the measurements in the irradiation room were difficult to perform. To obtain reliable gamma measurements, calibrated graphite-CO_2 filled ionisation chambers and Li^6-Sn-Pb shielded GM-counters were used. Neutron flux measuremants were performed using BF_3-counters and foil activation methods. It was experienced that the various techniques did not always give consistent results. Detailed results of these measurements and techniques used will be given in the paper.

Third United Nations International Conference on the Peaceful Uses of Atomic Energy

A/CONF.28/A/726
NETHERLANDS
February 1964
Original: ENGLISH

Confidential until official release during Conference

Abstract

The Norwegian-Netherlands' fuel irradiation project*)

R.G. Schölvinck, P.F. Sens
Reactor Centrum Nederland, Petten, the Netherlands
E. Jensen
Institutt for Atomenergi, Kjeller, Norway

Since 1962 experimental UO_2 fuel irradiations have been performed in a loop in the High Flux Reactor at Petten. The H.F.R. is an enriched uranium fueled, light water cooled, materials testing reactor, operating at a power of 20 MW.

The purpose of the experiments is to study the behaviour of UO_2 fuel, irradiated at high specific power to a high burn-up. Fuel capsules between 10 mm and 15 mm diameter are contained in a pressure tube, located in one of the beryllium reflector elements, adjacent to the reactor core. The in-pile section is of the re-entrant thimble type.

Dependent on location the effective thermal neutron flux in the fuel capsules is between 0.8 and 1.5 . 10^{14} $n/cm^2 sec$. Loop equipment and instrumentation are in the basement of the reactor building in a special shielded cubicle.

Operation of the loop has been satisfactory so far. Fuel ratings have been achieved up to 750 W/cm fuel length (kdT = 60 W/cm) and fuel exposures in excess of 10,000 MWD/tonne.

The post irradiation facilities consist of two lead cells (7" and 10" wall thickness) of the box in a cell type. Results of the post irradiation measurements will be presented. They include measurements on the change in dimensions of the fuel capsules, on the release of fission gases, on the burn-up, on grain growth and further metallographic observations.

*)Work carried out at Petten, The Netherlands, as a joint project of the Norwegian Institutt for Atomenergi and Reactor Centrum Nederland.

Third United Nations International Conference on the Peaceful Uses of Atomic Energy

A/CONF.28/A/727
NETHERLANDS
February 1964
Original: ENGLISH

Confidential until official release during Conference

Abstract

A new method for measuring brittle fracture in reactor vessel steels

H.C. van Elst, E.C.J. Buys, W.L. Korbee, C.A. Verbraak
Metal Institute T.N.O., Delft, the Netherlands

From a statistical evaluation of twinning resulting from brittle fracture in steel it could be concluded that the preferred directions of twinning in this case were similar to the preferred twinning directions in shockloaded specimens.

From this similarity of twin-directions it was concluded that a running brittle fracture in steel creates stress waves. Such an emission of stress waves by a brittle fracture, however, seems only conceivable if the fracture propagates by discrete steps.

Under Euratom contract it was possible for us to verify this point of view by applying ultra high speed photographic methods for the recording of brittle fracture phenomena in steelplates.

These experiments were performed with the aid of an AVCO Streak Camera and a Barr & Stroud Framing Camera.

The results of these experiments confirmed the hypothesis of intermittent brittle fracture propagation in steel. The propagation of a brittle fracture in steel proceeds as a sequence of alternatively sudden fracture steps and halting times.

Also the dynamic stress pattern at the tip of the moving brittle fracture and the emitted stress waves could be recorded, when a sheet of photostress material was glued to the steel plate.

The distancesbetween the observed successive stress waves are in agreement with those calculated from the fracture step lengths and halting times.

The emitted stress waves have a peak pressure of about 15 Kbar and a half time width of 5 μsec. Similar shock waves were produced in an artifi-

dial way and transferred through small cylindrical steel specimens (6 mm diameter, 6 mm length).

It was found that by measuring the energy absorption of such a shock wave at various temperatures a reasonable estimation could be made of the isothermal Robertson stop temperature.

This isothermal Robertson stop temperature is an important steel property in the qualification of reactor vessel steels.

It is now possible to determine the influence of radiation damage on the isothermal Robertson stop temperature with the aid of shock wave demping measurements which require only very small specimens.

Third United Nations International Conference on the Peaceful Uses of Atomic Energy

A/CONF.28/A/728
NETHERLANDS
February 1964
Original: ENGLISH

Confidential until official release during Conference

Abstract

Experiences on the design, calculation and the manufacture for power reactor components

K.J. de Jong, C. de Pater, M. van Veen
Neratoom Group, The Hague.

The Neratoom Group has dealt and is dealing with four main components for power reactors.
This paper describes components for the powerstations SENN, KRB and SEP, which are of the boilingwater type, designed by the U.S. General Electric.
Based on functional specifications, stress analysis and heattransfer calculations were prepared and the design made for the secondary steamgenerators for SENN.
Similar work will be carried out for the reactor pressure vessel for the 50 MWe SEP power station.
The core structures for the SENN en KRB power stations were and respectively will be manufactured to construction drawings provided by the client.

This paper reports on the extensive calculations describing the dynamic behaviour of the SENN steamgenerators.
The severe manufacturing and control requirements and the way on which these were realised are described.
Concerning subjects are: welding procedures, welding tests and control, cracktests and leaktests.

Methods applied to realise the high dimensional accuracy required in the specification for the corestructures will be described.

Concerning reactor pressure vessels the influence of the pressure vessel codes ruling in different countries will be discussed. As these requirements for calculation and control sometimes are insufficiently defined and sometimes fail completely, a matter of difference may be created.

We think it sensible to strive after an internationally accepted code for stress calculations and control requirements.

Moreover the two possibilities of manufacturing reactor pressure vessels viz. the application of forged rings and the application of rolled and bent plates will be discussed.